MULTI-STAGE CAVITY CYCLOTRON RESONANCE ACCELERATORS

ABSTRACT OF THE DISCLOSURE

A high-current, high-gradient, high-efficiency, multi-stage cavity cyclotron resonance accelerator (MCCRA) provides energy gains of over 50MeV/stage, at an acceleration gradient that exceeds 20MeV/m, in room temperature cavities. The multi-stage cavity cyclotron resonance accelerator includes a charged particle source, a plurality of end-to-end rotating mode room-temperature cavities, and a solenoid coil. The solenoid coil encompasses the cavities and provides a substantially uniform magnetic field that threads through the cavities. Specifically, the MCCRA is provided with a constant magnetic field sufficient to produce a cyclotron frequency a little higher than the RF of the accelerating electric field. A plurality of input feeds, each of which respectively coupled to a cavity, are also provided. According to an embodiment of the invention, the beam from the first cavity passes through a cutoff drift tube and is accelerated further with a cavity supporting a still lower radio-frequency electric field. This embodiment yields a several-milliampere one-gigavolt proton beam efficiently. The single cavity transfers about 70% of the radio-frequency energy to the beam. A multiple-cavity accelerator using a constant or slightly decreasing static magnetic field along its length and using cutoff drift tubes between the cavities operating at progressively lower frequencies, each somewhat lower than the local relativistic cyclotron frequency of the beam in that cavity, provides an extremely-efficient, compact, continuously-operating, medium-energy accelerator. In another embodiment of the invention, the progressively lower frequencies are selected to decrease in substantially equal increments corresponding to a difference frequency. The charged particles are emitted in pulses in correspondence with the difference frequency.